The Presence of Spotters Improves Bench Press Performance: A Deception Study

Original Investigation

Sheridan[1], A., Marchant[1], D.C., Williams[2], E.L., Jones[3], H., Hewitt[4], P.A., and Sparks[1], S.A

[1] Department of Sport and Physical Activity, Edge Hill University, Ormskirk, Lancashire, UK

[2] Centre for Sports Performance, Leeds Beckett University, Leeds, Yorkshire, UK

[3] School of Psychology, University of Central Lancashire, Preston, Lancashire, UK

[4] Sport Liverpool, University of Liverpool, Liverpool, UK.

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Corresponding Author:
Dr Andy Sparks
Department of Sport and Physical Activity
Edge Hill University
St Helens Road
Ormskirk
Lancashire
L39 4QP
UK

Email: andy.sparks@edgehill.ac.uk
Tel: +44 (0)1695584638

ABSTRACT

Resistance exercise is a widely-used method of physical training in both recreational exercise and athletic populations. The use of training partners and spotters during resistance exercise is widespread, but little is known about the effect of the presence of these individuals on exercise performance. The purpose of the current study was to investigate the effect of spotter presence on bench press performance. Twelve recreationally trained participants (age, 21.3 ± 0.8 yrs, height, 1.82 ± 0.1 m, and weight, 84.8 ± 11.1 kg) performed two trials of three sets to failure at 60% of 1 repetition maximum on separate occasions. The two trials consisted of spotters being explicitly present or hidden from view (deception). During the trials, total repetitions (reps), total weight lifted, ratings of perceived exertion, and self-efficacy were measured. Total reps and weight lifted were significantly greater with spotters (difference = 4.5 reps, $t = 5.68$, $p < 0.001$; difference = 209.6 kg, $t = 5.65$, $p < 0.001$; respectively). Whilst RPE and Local-RPE were significantly elevated in the deception trials (difference = 0.78, $f = 6.16$, $p = 0.030$; difference = 0.81, $f = 5.89$, $p = 0.034$ respectively), self-efficacy was significantly reduced (difference = 1.58, $f = 26.90$, $p < 0.001$). This study demonstrates that resistance exercise is improved by the presence of spotters, which is facilitated by reduced RPE and increased self-efficacy. This has important implications for athletes and clients, who should perform resistance exercise in the proximity of others, to maximize total work done.

Keywords: Resistance exercise, training, social facilitation, self-efficacy

INTRODUCTION

Resistance exercise forms a considerable proportion of training loads for athletes and is increasingly prescribed by health professionals for recreational gym users (36). The popularity of resistance exercise is also increasing due to the visible physical benefits such as weight loss and increased muscle mass, and increased self-esteem (26). These beneficial adaptations are also linked to reduced visceral fat and increased insulin sensitivity (10, 36). Such benefits have also shifted perceptions of the effectiveness of resistance exercise as a prescribed activity for the treatment and prevention of some non-communicable diseases, and for athletic training (32). Training adaptation goals, such as increasing muscular strength, power, endurance, and hypertrophy require different training methods (1, 31). The training outcome requires specific volume, intensity and rest periods to bring about the desired skeletal muscle response (3). Increased evidence for the efficacy of resistance exercise for both health and sport performance has prompted an increase in research interest which has sought to investigate methods of further enhancing these beneficial training adaptations and performance.

Several studies have attempted to investigate the effects of the social interaction during resistance training programmes. Indeed, social facilitation (41) and the presence of training partners, coaches or personal trainers have previously been shown to improve strength and power following 12-week training programmes (12, 23). This has led to the commonly held belief that adherence and enjoyment of resistance exercise may be improved in more social situations especially in less well trained populations. In diabetic patients prescribed resistance exercise, the presence of additional individuals in the exercise environment has been shown to be facilitative (34). Conversely, in other type of exercise, such as individual endurance activities, the use of social situation effects has been shown to have no influence on self-determined running duration, speed or post exercise ratings of exertion (RPE), during recreational running (11). Interestingly however, when a competitor is present during time trial cycling, performance improvements have been observed, as a result of external attentional focus mediated reductions in perceptions of effort (39). Furthermore, the presence of a team-mate avatar, within a virtual exercise environment, facilitated self-paced rowing in female exercisers (25), suggesting that some individuals, might feel additional pressure to appear skilful and competent, in the presence of others, and so perform better. At present, it is unclear if such acute changes to performance, occur during resistance exercise activities when the social situation in manipulated.

Strength and conditioning training requires significant mental effort, the characteristics of which, influence movement quality and quantity, and therefore related physiological adaptations (17). One such variable that drives effective physical effort is self-efficacy (40). Bandura's self-efficacy theory (6) suggests that self-judgement of personal capability has a critical influence on goal directed behaviour. Importantly in training settings, one’s self-efficacy influences both the amount of effort and the length of time that effort is invested (7). Furthermore, self-efficacy is a state variable that fluctuates in accordance with changing perceptions of the self, the task and environment. Accordingly, Rhea, et al (27) showed that one repetition maximum (1RM) bench press performance was improved by 12.9% when participants underwent the test in the presence of an audience of spectators. The employment of such social facilitation effects may have important implications for training impulse and exercise adherence (29). Whilst the presence of an audience during a competitive situation appears to improve resistance exercise performance, it remains unclear if the proximity of a small number of individuals, has similar effects. This is important, since most training sessions take place in either solo situations of in the presence of a few training partners of spotters.

Currently, little is known about the effects of spotter presence on the individual performing the exercise. However, the National Strength and Conditioning Association (NSCA) recommend the use of spotters during resistance protocols (15) and the generally held belief that exercise with social facilitation is desirable (11). Wise et al., (40) demonstrated that exercise trainers could influence the self-efficacy of novice female exercisers to complete bench press exercise through highlighting their professional qualifications, providing specific feedback, and communicating beliefs about the exerciser's ability. Despite the important role of exercise trainers in instructing and supporting exercisers, less is known of their additional role within the strength training environment acting as a spotter. It is possible that the spotter not only has a social-facilitating effect on performance, but also supports self-efficacy through behaviors explicitly highlighting their beliefs in the exerciser's ability to complete exercise movements. Conversely, the lack of any active intervention from the spotter, may also influence self-efficacy. Therefore, the aim of the present study was to determine the effect of the presence of spotters on performance and the psychophysiological responses during bench press exercise. It was hypothesized that the visual presence of spotters would lead to improved performance because of increased desire to perform mediated by associated social facilitation effects.

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

An experimental design consisting of three laboratory visits was used. Following the initial determination of 1RM, two subsequent experimental trials performed in a randomized cross-over manner were used. During the experimental trials sets of bench press exercise to failure were performed, during which participant's awareness of the presence of spotters was manipulated. The chosen method to achieve this was via a deceptive approach, whereby in one of the trials, spotters were openly present and visible to the participants (Spotter) whilst in the other trial they remained present, but hidden from view (Deception). During the exercise bouts, dependent variables of performance, perceptions of effort, self-efficacy and blood lactate were measured.

SUBJECTS

Twelve recreationally trained male participants (Table 1) were recruited for this study. All participants gave written informed consent prior to any data collection and then underwent pre-exercise medical screening. Participants had experience of resistance training for a minimum of 12 months and were training 4.6 ± 1.0 times per week. The participants were all injury free for the past six months, of low health risk and data collection took place between January and March in the northern hemisphere. This study was approved by the local Research Ethics Committee. The true deceptive nature and aim of the study was kept hidden from the participants. Participants were initially told the aim of the study was to assess the test-retest reliability of the lifting protocol. Following the completion of data collection, all participants were fully debriefed as to the true nature of the experiment.

[Insert Table 1 near here]

PROCEDURES

Prior to the start of data collection, participants were told to avoid ingesting food within two hours of exercise as well as pre-workout supplements. They were also instructed to limit caffeine consumption, and to ensure they were adequately hydrated by consuming at least 1 litre of water in the 2-4 hours prior to testing, in order to reduce the negative impact of dehydration on resistance exercise performance (18). Participants were required to replicate this regimen on all subsequent laboratory visits using a 24 hour diet diary. During the first laboratory visit, all participants underwent body composition analysis using air displacement plethysmography (BodPod, Cosmed, Rome, Italy). Immediately after this, the participants were required to demonstrate a safe unloaded bench press on a Smith machine (Hammer Strength, Life Fitness, Ely, UK). Participants then completed a four-minute warm up of low intensity cycling against no additional resistance (874E, Monarch Exercise AB, Vansbro, Sweden) maintaining a speed of 70 rpm. Two sets of 10 s hold upper body stretching were completed, of chest, shoulders, and triceps muscle groups (37). To ensure consistent performances, and despite the participants being experienced, coaching points devised by the NSCA were given during the warm up, prior to any testing (13). Bench press 1RM was then determined using the protocol standardized by the NSCA (24), which is widely used to measure maximal strength (4). This involved the performance of a 12-repetition warm-up set at 10% of estimated 1RM on a Smith machine (Hammer Strength, Life Fitness, Ely, UK). On completion of the initial set, participants then rested for one minute before performing a six-repetition set with an additional 20% load. Then, after a further 2-minute rest period, a final warm-up set of three repetitions with an estimated near maximal load added was completed. An estimation of the 1RM was then made and participants were allowed to attempt single lifts. If they were successful, 1.25, 2.5 or 5 kg was progressively added to the bar in order to determine the actual 1RM. Each lift attempt was completed following a 2-4 minute rest and all 1RM's were determined within 3-6 attempts.

The participants were then required to attend the laboratory on two further occasions to perform either the spotter trial or the deception trial. In both trials two spotters were presence, one spotter at either side of the Smith machine bar, during lifts. In the spotter trial, their presence was made visually obvious to the participants, before and on completion of each set. In the deception trial, spotters remained in place only during the lifts, but not visible to the participants, and then moved to remain hidden from view during the rest periods between sets. This was achieved, by using opaque material shielding around the Smith machine frame, which was in place during both experimental trials. This allowed the bar and weight plates to move freely, whilst obscuring the view of the spotters from the participants when needed. Participants were told that the shielding was to reduce the chances of peripheral distractions, and were instructed to focus on a marker, which had been placed on the middle of the bar. During the trials, the same male principle investigator was visible to the participants and the same male spotters were used for all trials.

The lifting protocols required participants to complete the same cycling and stretching warm up outlined prior to the 1RM testing, followed by a set of 10 bench press repetitions with no weight on the bar, in order to limit the likelihood of injury (14) and attain maximal force output (35). The participants were then shown the loaded bar and told that this was 60% of their 1RM, after which they performed three sets of bench press reps to failure at 60% of 1RM unassisted with two-minute rest periods between sets (38). This exercise protocol was chosen because it has previously been shown to have a low test-retest coefficient of variation (2.1-6.6%) and therefore has good reliability (16) and been previously used to determine performance differences in a similar population (24). The principle investigator recorded the number of reps in each set and the total weight lifted in each trial. No verbal encouragement was given to the participants. Prior to each set the participants received the same scripted verbal instructions: [1] *"Maintain your visual focus on the bar throughout each set",* [2] *"Think about the movement of the bar*", [3] "*Lift to failure*". This was done in order to maximize muscular endurance (21, 22).

Capillary blood lactate concentrations were measured from the earlobe (Lactate Pro 2, Arkray, Japan) prior to the start of each trial and at the end of the third set. Ratings of perceived exertion (RPE) and the local RPE (L-RPE) of the chest and arms were measured following the completion of each set using a 6-20 scale (9). Prior to the start of sets 2 and 3, rating of self-efficacy to replicate the performance of the previous set, during the next set, was assessed using a numeric 1-10 scale. This was anchored with 1 representing no confidence, and 10 representing fully confident. At each measurement point, participants were asked *"how confident are you that you will match the previous number of repetitions"?* Each participant performed the trials with a minimum of three days between laboratory visits, to minimize the effects of delayed onset muscle soreness (28), but not more than seven days apart.

STATISTICAL ANALYSIS

All data were analyzed for normality using standard graphical procedures. Thereafter, main effects for experimental condition, set and condition*set interactions were determined using repeated measures ANOVA for the number of reps, RPE, L-RPE, blood lactate and self-efficacy. Post-hoc pairwise comparisons were made using the Bonferroni adjustment where main effects were observed. Comparisons between experimental conditions were made using paired t-tests for the total number of reps per trial and the total weight lifted, as well as to determine differences at each measurement point for all variables. Effect sizes were determined using η_p^2 for ANOVA and Cohen's d for paired t-tests, along with 95% confidence intervals (CI). Effect sizes were categorized as small, medium and large effects using values of 0.01, 0.06, 0.14 for η_p^2 and 0.2, 0.5, 0.8 for Cohen's d respectively. Statistical significance was regarded as $p < 0.05$, and all procedures were conducted using SPSS v22 for Windows (IBM Inc., Portsmouth, UK).

RESULTS

The visible presence of the spotters resulted in a significant increase in the total number of reps (Figure 1) and the total weight lifted (Figure 2) during the two conditions (mean difference = 4.5 reps, CI = 2.8 to 6.2, $t = 5.68$, $p < 0.001$, $d = 1.64$ and mean difference = 209.63 kg, CI = 128.0 to 291.2, $t = 5.65$, $p < 0.001$, $d = 1.63$ respectively). Furthermore, there was a significant main effect of the spotters presence across all three sets ($f = 32.2$, $p < 0.001$, $\eta_p^2 = 0.75$) with the deception trial resulting in significantly poorer performances in all three (mean difference = 1.42 reps, $t = 2.49$, $p = 0.03$, $d = 0.72$; mean difference = 1.83 reps, $t = 5.70$, $p < 0.001$, $d = 1.64$; mean difference = 1.25 reps, $t = 3.56$, $p = 0.004$, $d = 1.03$ for sets 1, 2, and 3 respectively). There was also a significant main effect for the number of reps performed in each set ($f = 87.3$, $p < 0.001$, $\eta_p^2 = 0.89$), with the number of reps performed reducing through each trial (mean differences = 6.3, 3.2 and 9.5 reps, $p < 0.001$, for set 1-2, set 2-3 and set 1-3 respectively). When data were re-organised to reflect trial 1 versus trial 2, no trial order effect was detected for total number of reps performed (mean difference = 0.50 reps, CI = -2.9 to 3.9, $t = 0.32$, $p = 0.755$, $d = 0.07$). The blood lactate responses (Table 2) were significantly higher in the spotter condition following the completion of the three sets (mean difference = 1.19 $mmol.l^{-1}$, CI = 0.23 to 2.16, $t = 2.72$, $p = 0.002$, $d = 0.78$), but not prior to the start of exercise (mean difference = 0.05 $mmol.l^{-1}$, CI = -0.13 to 0.23, $t = 0.61$, $p = 0.56$, $d = 0.18$). This resulted in significant main effects for condition ($f = 7.74$, $p = 0.018$, $\eta_p^2 = 0.41$), time ($f = 294.01$, $p < 0.001$, $\eta_p^2 = 0.96$) and a condition*time interaction ($f = 6.54$, $p = 0.027$, $\eta_p^2 = 0.37$).

[Insert Figure 1 near here]

[Insert Figure 2 near here]

Ratings of perceived exertion (Table 2) were significantly higher in the deception condition when spotters were not visible ($f = 6.16$, $p = 0.03$, $\eta_p^2 = 0.36$) in set 1 (mean difference = 0.83 AU, CI = -1.64 to -0.03, $t = 2.28$, $p = 0.044$, $d = 0.66$) and set 2 (mean difference = 1.00

AU, CI = -1.86 to -0.14, t = 2.57, p = 0.026, d = 0.74), but not in set 3 (mean difference = 0.50 AU, CI = -1.29 to 0.29, t = 1.39, p = 0.191, d = 0.40). As the sets progressed, RPE significantly increased in both conditions ($f = 54.44$, $p < 0.001$, $\eta_p^2 = 0.83$). Similar responses were observed for L-RPE (Table 2), with significant main effects for condition ($f = 5.89$, $p = 0.034$ $\eta_p^2 = 0.35$), and sets ($f = 113.11$, $p < 0.001$, $\eta_p^2 = 0.91$). The L-RPE was significantly higher in the deception trial after set 1 (mean difference = 1.08 AU, CI = -1.96 to -0.21, t = 2.72, p = 0.02, d = 0.79), but not following set 2 (mean difference = 0.58 AU, CI = -1.46 to 0.29, t = 1.47, p = 0.171, d = 0.42) or set 3 (mean difference = 0.75 AU, CI = -1.69 to 0.19, t = 1.75, p = 0.108, d = 0.51). Self-efficacy was significantly higher in the spotter condition ($f = 26.90$, $p < 0.001$, $\eta_p^2 = 0.69$), both after set 1 (mean difference = 1.85 AU, CI = 0.83 to 2.86, t = 3.97, p = 0.002, d = 1.21), and set 2 (mean difference = 1.31 AU, CI = 0.64 to 1.98, t = 4.25, p = 0.001, d = 1.31), but there were no significant within-trial changes to the self-efficacy ratings as the sets progressed ($f = 0.67$, $p = 0.43$, $\eta_p^2 = 0.05$) in either condition.

[Insert Table 2 near here]

DISCUSSION

This is the first study to investigate the influence of the presence of spotters on resistance exercise performance, using a deceptive strategy. This type of experimental design allowed the presence of the spotters to remain during the exercise trials whilst obscuring them from the view of the participants. On completion of both trials, during the debriefing process, all participants confirmed that they had been unaware of the true nature of the study, and had not detected the spotters during the deception condition. The performance of three sets of bench press exercise to failure, at 60% 1RM in trained participants, was increased by 11.2 ± 8.1%, for both number of reps and total work when spotters are visible. Interestingly, 11 of the 12 participants performed best in the spotter condition (5.3 – 30.7% improvement range), and the participant that did not, performed identically in both conditions. This observed performance improvement occurred independently of a trial order effect, the percentage improvement of which, was larger than the previously observed inter-trial reliability, suggesting a significant and measurable improvement when spotters are present. Furthermore, it would appear that post-set RPE significantly decreased after the first two sets, and ratings of self-efficacy were considerably enhanced when spotters were obviously present. These findings show the acute effects of the close proximity of a small number of people during lifts, whereas previous work has demonstrated the chronic effects on adherence to training (12, 23, 34) or of the effects of an audience during a competitive situation (27). These finding are important as they demonstrate that performance, and therefore training impulse, may be enhanced with the presence of close observers, documenting for the first time that the perceived absence of these individuals has a negative impact on total work done.

The influence of spotters on lifting performance appears to be derivative of social-cognitive and perceptual variables, specifically through supporting positive self-efficacy towards the task and lower perceptions of effort. In the present study, self-efficacy was enhanced with the presence of the spotters supporting the assertion that the verbal and nonverbal communication from others influence self-efficacy beliefs (30). Although the spotters did not provide verbal encouragement, their physical behavior explicitly acts on social persuasive mechanisms proposed to support self-efficacy (6). Their active intervention in the lift indicates a judgement on the limit of the lifter's ability. As such, when the participant is aware of the spotters' non-intervention, this supports the self-efficacy by confirming the belief in their ability to continue. Consequently, participants then invest further effort to improve their performance, which caused greater increases in blood lactate concentrations at the end the spotter trials. A proposed theoretical mechanism to explain these effects is through relation-inferred self-efficacy (RISE) which is influenced by verbal and non-verbal behavior (30). In the present context, Lent and Lopez's conceptual model (20) proposes that RISE is generated through the lifter's perceptions of interpersonal cues from the spotter. By not intervening, this is interpreted as the spotters' confidence in the participant's ability to continue with the exercise. The social-cognitive environment within which strength and conditioning training is undertaken, is a key consideration when aiming to maximize performance (8).

The effect of the mere presence of others on performance, according to social facilitation theory, tends to be weak (33). However, the nature of the interaction and behavior of the social influence is suggested to be important mediating factors of the social facilitative effect. According to social impact theory**,** the impact of social presence on emotions and behavior is determined by multiplicative 'social forces' including size (one or more people present), immediacy (proximity) and social source strength (importance) (19). In the present study when both spotters were visibly present to the participants, they remained in close proximity of the bar throughout the exercise bouts and rest periods. During this period, the investigator also remained in view, further increasing the number of individuals that were present and reinforcing the importance of the task at the start of each set. Clearly the behavior of the investigator remained consistent in every trial, so it is perhaps more likely that the factor that seem to have facilitated improvements in performance in the spotter conditions are more strongly linked to the number and proximity social forces. In conditions where the audience or the number of individuals present increases, there is a greater impact on emotions and behavior (27). Individuals tend to have a pervasive desire to be viewed in a positive light and will engage in impression management behaviors in order to achieve this (2). As the presence of people increases, there is an increased tendency to manage these impressions.

In the present study, the participants all had experience of weight training and may have therefore had a greater desire to be perceived as competent in the task, when the researcher and spotters were both visibly present. To manage and satisfy this impression of competency, an increase in effort would be a likely strategy, and therefore support the findings of a better performance attained in the spotter condition.

The proximity of the social presence has also been found to moderate the effect of social size on emotions and behaviors (2). Partially interactive social influences may have a different effect than non-interactive (audience) or active (competitor or co-actor) influences. The interaction may be based on verbal/nonverbal communication or behavior of the social presence. A spotter is suggested to be present in a number of resistance exercise settings (15) and acts as a partially active social influence, whereas an audience/spectator is non-active without direct interaction and can be classed as 'mere presence'. This could explain the greater magnitude of the effect of spotters on performance, SE and RPE in the present study versus the smaller or trivial effects previously found in research exploring audience effects (33).

Similar performance improvements have been previously observed in 12-week training program interventions, using direct supervision of youth rugby league players (12) and moderately resistance trained males (23). Notably, the present study suggests that close proximity of spotters influences the performance of bench press exercise, but the nature and role of the individuals that are present during such activities, might also be important in potentially enhancing training impulse (12, 23). Future studies should therefore investigate the presence of spotters on a wider variety of resistance exercise activities, but more crucially the nature, behavior and interaction of the spotter with the athlete/client.

PRACTICAL APPLICATIONS

Improved performance of bench press exercise to failure is mediated by perceptions of spotter presence. Therefore, coaches and exercise professionals should ensure that their athletes or clients, perform resistance exercise in the proximity of others, ideally in a spotting role. This is not just due to the potential safety benefits, but also because this is likely to cause an observable improvement in total work done, which occurs with enhanced self-efficacy and reduced ratings of effort. This has important implications for measurements of exercise capacity, client self-efficacy and those using this type of exercise protocol as a performance criterion.

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Table 1. Mean (±SD) participant characteristics.

Descriptive	Data
Age (yrs)	21.3 ± 0.8
Height (m)	1.82 ± 0.07
Weight (kg)	84.8 ± 11.1
Body Fat (%)	18.2 ± 6.2
Fat Mass (kg)	15.6 ± 5.7
Fat Free Mass (kg)	73.1 ± 24.2
1RM (kg)	85.0 ± 23.5

Table 2. Mean (±SD) of all psychophysiological variables. (*) Denotes a significant difference between conditions ($p < 0.05$); (‡) Denotes a significant difference from pre-exercise ($p < 0.001$); and (†) Denotes a significant difference from previous set ($p < 0.05$).

	Condition	
Variable	**Spotter**	**Deception**
Lactate Concentration ($mmol.l^{-1}$)		
Pre	1.0 ± 0.3	1.0 ± 0.2
Post	6.8 ± 1.6‡	5.6 ± 1.0‡*
RPE		
Set 1	10.8 ± 1.7	11.7 ± 2.2*
Set 2	13.0 ± 2.1†	14.0 ± 1.7†*
Set 3	15.0 ± 2.2†	15.5 ± 1.6†
L-RPE		
Set 1	11.2 ± 1.8	12.3 ± 2.3*
Set 2	14.2 ± 1.8†	14.8 ± 1.6†
Set 3	15.8 ± 2.1†	16.5 ± 1.7†
Self-efficacy		
End of Set 1	6.4 ± 1.6	4.4 ± 1.3*
End of Set 2	6.3 ± 1.4	4.9 ± 1.4*

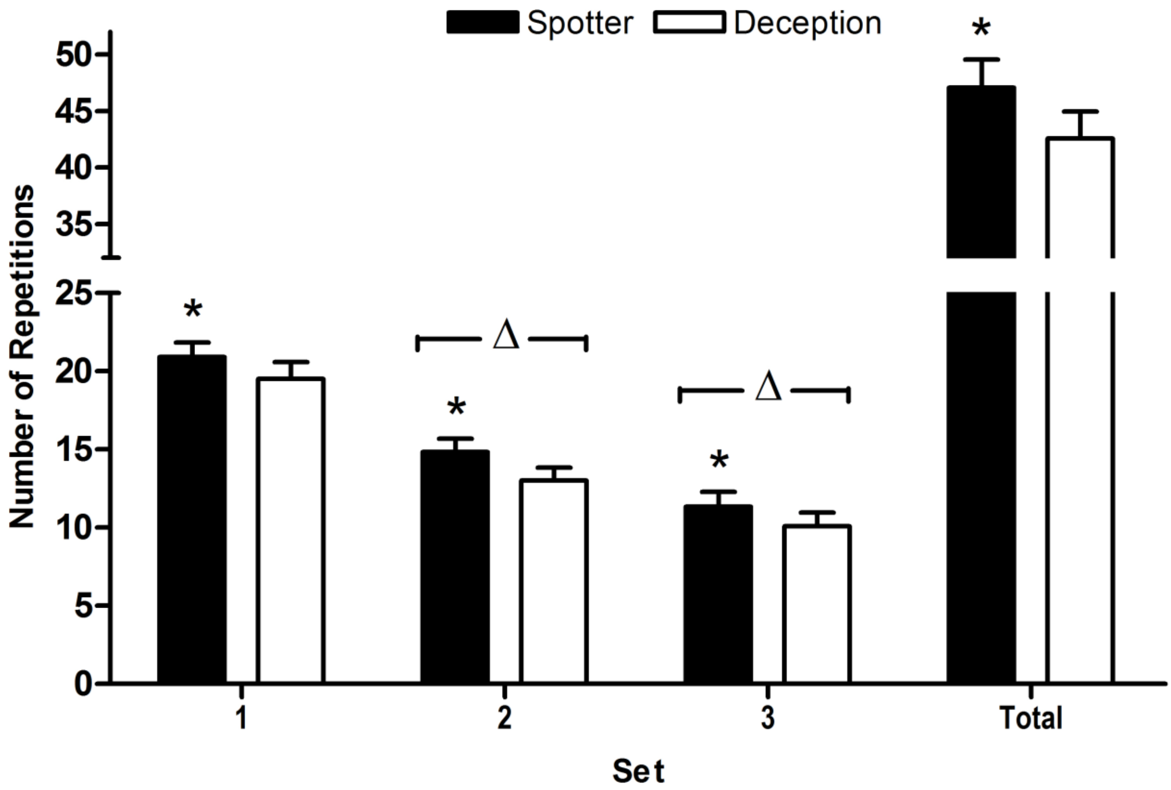

Figure 1. Mean (± SEM) bench press repetition performance. (*) Denotes a significantly higher number of repetitions between conditions ($p < 0.05$); and (Δ) Denotes a significant reduction in repetitions from the previous set ($p < 0.001$).

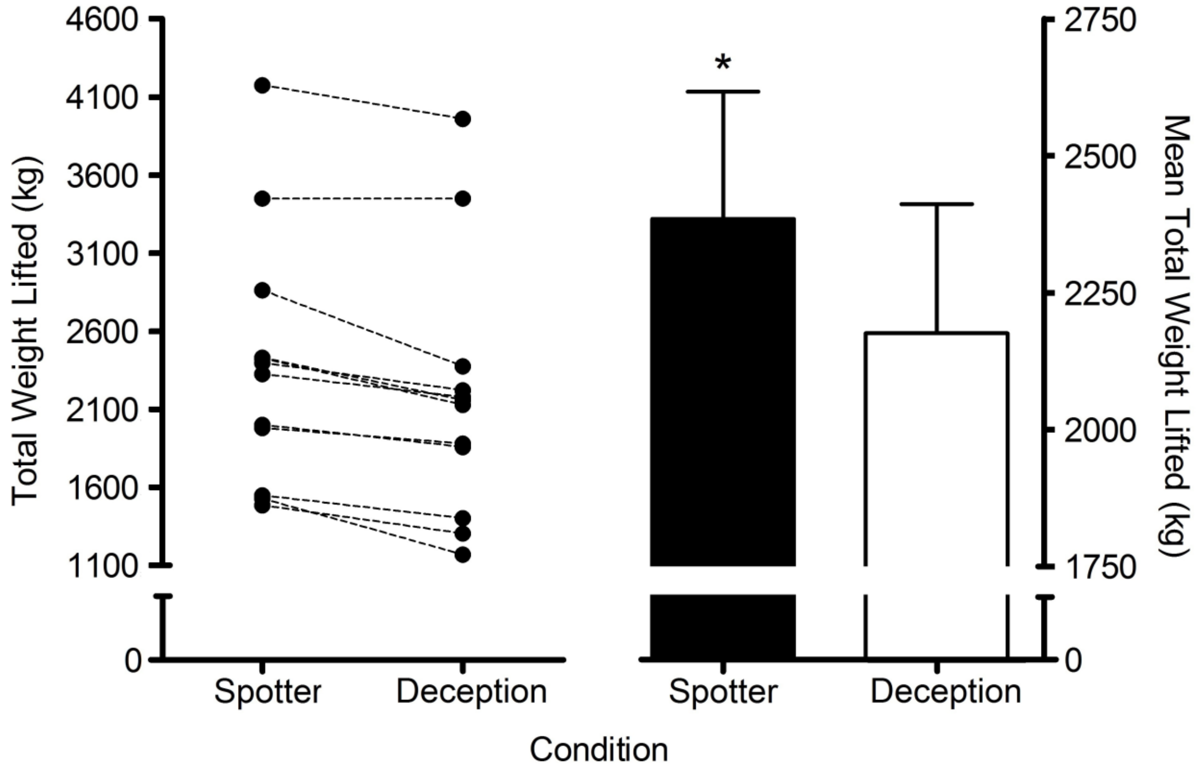

Figure 2. Individual and mean (± SEM) total weight lifted during bench press performance. (*) Denotes a significant difference between conditions ($p < 0.05$).